rupture and aneurysm diameter relative to body size for men and women with the goal of testing a novel method of rupture risk stratification that is more appropriate for women.

Methods: We reviewed all patients in the Vascular Surgery Group of New England database who underwent endovascular or open AAA repair. We evaluated height, weight, body mass index (BMI), and body surface area (BSA) as well as each of these values indexed to the aortic diameter (eg, BSA index = aneurysm diameter (cm)/BSA [m^2]). Along with other relevant clinical variables, we constructed multivariable-adjusted logistic regression models using forward selection to determine predictors of rupture repair vs elective repair. Models for men and women were developed separately, and different models were compared using the area under the curve (AUC).

Results: We identified 4045 patients who underwent AAA repair (11% ruptured, 53% EVAR, 78% men). Women had significantly smaller diameter aneurysms, lower BSA, and higher BSA indices than men (Table). For men, the primary determinant of rupture was aneurysm diameter (AUC, 0.82): <55 mm (referent); 55-64 mm (OR, 0.9; 95% CI, 0.5-1.7; $P = .771$); 65-74 mm (OR, 3.9; 95% CI, 1.9-1.0; $P < .001$); and ≥75 mm (OR, 11.3; 95% CI, 4.9-25.8; $P < .001$). In contrast, BSA index was most predictive of rupture for women (AUC, 0.81), with higher odds of rupture at higher BSA indices: <25 (OR, 3.9; 95% CI, 0.5-28.2; $P = .175$); 25-29 (OR, 3.3; 95% CI, 0.8-14.5; $P = .111$); 30-34 (referent); 35-39 (OR, 6.4; 95% CI, 1.7-24.1; $P = .006$); and ≥40 (OR, 9.5; 95% CI, 2.3-39.4; $P = .002$). For women, aneurysm diameter alone was not a significant predictor of rupture after adjusting for BSA index.

Conclusions: Aneurysm diameter indexed to body size is the most important determinant of rupture for women, whereas aneurysm diameter alone is most predictive of rupture for men. Women with the largest diameter aneurysms and the smallest body sizes are at the greatest risk of rupture.

Table. Demographics and multivariable predictors of ruptured repair

Variables	*Men (n = 3138)*		*Women (n = 907)*	P
Demographics				
Age, mean (SD) years	71.9 (8.7)		74.3 (7.7)	<.001
Aneurysm diameter, mm				<.001
20-54, No. (%)	1032 (32.9)		368 (40.6)	
55-64, No. (%)	1170 (37.3)		350 (38.6)	
65-74, No. (%)	452 (14.4)		111 (12.2)	
≥75, No. (%)	483 (15.4)		78 (8.6)	
BSA, m^2[a]				<.001
<1.8, No. (%)	405 (12.9)		551 (60.7)	
1.8-1.9, No. (%)	1073 (34.2)		258 (28.5)	
≥2.0, No. (%)	1660 (52.9)		98 (10.8)	
BSA index, cm/m^2[b]				<.001
<25, No. (%)	668 (21.3)		77 (8.5)	
25-29, No. (%)	1136 (36.2)		231 (25.5)	
30-34, No. (%)	678 (21.6)		297 (32.7)	
35-39, No. (%)	342 (10.9)		171 (18.8)	
≥40, No. (%)	314 (10.0)		132 (14.5)	
Predictors of ruptured repair	*OR (95% CI)*[c]	P	*OR (95% CI)*[d]	P
Aneurysm diameter, mm				
20-54, %	1.0		1.0	
55-64, %	0.9 (0.5-1.7)	.8	1.1 (0.3-3.7)	.85
65-74, %	3.9 (1.9-8.0)	<.01	3.3 (0.8-12.7)	.09
≥75, %	11.3 (4.9-25.8)	<.01	3.2 (0.7-14.5)	.13
BSA Index, cm/m^2[b]				
<25, %	0.6 (0.3-1.4)	.23	3.9 (0.5-28.2)	.18
25-29, %	0.8 (0.5-1.5)	.53	3.3 (0.8-14.5)	.11
30-34, %	1.0		1.0	
35-39, %	0.8 (0.5-1.4)	.52	6.4 (1.7-24.1)	<.01
≥40, %	1.4 (0.8-2.6)	.2	9.5 (2.3-39.4)	<.01

[a]BSA = BSA (m^2) = $0.20247 \times \text{Height (m)}^{0.725} \times \text{Weight (kg)}^{0.425}$.
[b]BSA index = aneurysm diameter (cm)/BSA (m^2).
[c]Area under the curve = 0.82.
[d]Area under the curve = 0.81.

A 20-Year Experience With Endovascular Repair of Abdominal Aortic Aneurysms: A Record of the Development and Evolution of Techniques, Devices, and Strategies

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Objectives: Endovascular repair of abdominal aortic aneurysms (EVAR) has become the first-line treatment of abdominal aortic aneurysms (AAA) worldwide. Since the first successful EVAR in North America, the authors have maintained a continuous, prospective database recording the details of each procedure.

Methods: Between 1992 and 2012, 1268 patients (mean age, 75 years; 85% men) underwent EVAR for repair of AAA. Fifteen different types of stent grafts were used (Table). Eighty-one percent of patients exhibited high-risk characteristics that would preclude participation in Food and Drug Administration-mandated, industry sponsored-IDE pivotal trials. Ninety-three percent of patients had at least one severe comorbid medical condition, with an average of 2.2 conditions per patient. During EVAR, 38% had concomitant treatment of associated common iliac artery aneurysms. Mean follow-up was 38.2 months.

Results: Major perioperative complications occurred in 7.5%, with a perioperative mortality rate of 2.5%. Aneurysm size remained stable or decreased (>5 mm) in 86.5% of patients and increased (>5 mm) in 13.5%; median time to aneurysm expansion was 8.2 years. During follow-up, type I endoleak occurred in 2.1% of patients and type III in 0.2%. Reintervention was required in 21% of patients. Mean time to reintervention was 26 months. Freedom from aneurysm-related mortality was 91.1% at 12 years. Median survival for all-cause mortality was 5.6 years.

Conclusions: Progressive advances in EVAR allow safe, effective, and durable repair of AAA, extending the instructions for use parameters of commercially available devices.

Table 1. Operative data

	Mean ± SD
Anesthesia time (hours)	5.05 ± 1.51
Surgery time (hours)	3.70 ± 1.47
Estimated blood loss (mL)	367.8 ± 515.3
Transfusion volume (mL)	645.3 ± 647.4
Length of hospitalization (days)	2.75 ± 5.96
Initial aneurysm size (cm)	5.9 ± 1.2
Aneurysm size at latest F/U (cm)	5.5 ± 1.6
	No. of patients	*%*
Pre-operative adjunctive procedure(s)	438	34.6%
Patients receiving transfusion	181	14.3%
General anesthesia	75	5.9%
Spinal or epidural anesthesia	1085	85.8%
Tube graft	59	4.7%
Bifurcated graft	992	78.2%
Aorto-uni-iliac graft	207	16.3%
Physician-made EVSGs	109	8.6%
Industry-made EVSGs	1159	91.4%
Discharge on postoperative day 0 or 1	802	63.4%
Major perioperative complications	95	7.5%
Perioperative mortality	32	2.5%

The Incidence of Contralateral Iliac Venous Thrombosis After Stenting Across the Iliocaval Confluence in Patients With Acute or Chronic Venous Outflow Obstruction

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Objectives: Percutaneous transluminal angioplasty and stenting of the iliac veins is becoming a more common method of treating patients with symptomatic lower extremity venous outflow obstruction. Several questions about the conformation of these stents remain to be answered. One, in particular, is whether these venous stents should extend into the vena cava or stop short of this in fear of causing further harm to the patient's contralateral leg.

Methods: We retrospectively reviewed prospectively collected data from 2008 to 2012 in patients with symptomatic iliocaval venous thrombosis who underwent percutaneous angioplasty and stenting. Data were collected using the AVF venous stent database variables. Most patients were maintained on full anticoagulation using warfarin (international normalized ratio 2-3) or low-molecular-weight heparin (weight-based daily or b.i.d. dosing). Patients with first time deep venous thrombosis were anticoagulated for 6 months on average, and those with repeat deep venous thrombosis were maintained on lifelong anticoagulation. Intraoperative anticoagulation was performed using intravenous heparin. Contralateral thrombosis and patency rates were recorded.

Results: A total of 183 iliocaval stents were placed in 66 patients (median age, 43; range 15-80 years), of which 63 patients experienced thrombosis causing the venous outflow obstruction. Thirty patients experienced acute venous thrombosis, 25 chronic, and nine acute on chronic. Forty-eight of 66 patients (72.7%) had patent stents noted on duplex

ultrasound imaging at 1 year, 10 patients have no follow-up data (three of whom surgery was recently completed, seven of which were lost to follow-up), and eight patients experienced thrombosis. Stents extended into the inferior vena cava crossing the normal contralateral side in 45 of 66 patients (68%). Seven of these patients (15%) suffered new thrombosis of the nonstented contralateral side. Three of these seven patients were totally noncompliant with their postoperative anticoagulation; thus, 8% of compliant patients had new contralateral thrombosis after stenting across a normal contralateral common iliac vein and into the vena caval wall.

Conclusions: To date, there is no consensus whether to stent across the thrombosed common iliac vein into the cava or completely across and into the vena cava. From these data it appears that stenting across the iliocaval confluence can result in a small percentage of contralateral thrombosis despite chronic therapeutic anticoagulation. This data will help us move forward in the development of new technologies and in the treatment of these patients.

Surgical Reconstruction of the Cephalic Arch for the Management of Dysfunctional Brachiocephalic Arteriovenous Fistulas

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Objectives: Development of recalcitrant stenotic lesions of the cephalic arch is a common failure mode of brachiocephalic arteriovenous fistulas. Endovascular treatment is the first line of therapy for cephalic arch stenosis. Suboptimal outcomes have led to exploration of surgical alternatives. We evaluated our initial experience with a cephalic arch reconstruction to salvage malfunctioning brachiocephalic arteriovenous fistulas (AVFs).

Methods: We retrospectively reviewed all patients requiring surgical revision of compromised brachiocephalic AVFs due to cephalic arch stenosis. Percutaneous interventions had failed in all patients, and they underwent cephalic arch reconstruction (CAR) for salvage. Indications, clinical considerations, and surgical technique were studied; initial patency, complications and reinterventions were reviewed.

Results: From April 2011 to July 2012, 15 patients (54% women, mean age 55 ± 22 years) underwent CAR. Stenotic lesions of the cephalic arch at the confluence with the axillary vein were confirmed by contrast venography. The average number of percutaneous interventions prior to the decision to CAR was three (range, 2-7). The time from access creation to cephalic arch reconstruction was 33 months. Surgical approach involved revisions of the cephalic arch to redirect the flow as a direct reconnection to the axillary or as a turndown procedure to the brachial vein in the axilla. Technical success was 100%: all patients were able to use successfully their access for dialysis after the procedure. Two patients (13%) required angioplasty of the CAR due to restenosis, another patient required evacuation of hematoma in postoperative day 14. At a mean of 12 months of follow-up, all AVFs remain functional.

Conclusions: The initial experience with cephalic arch reconstruction demonstrates that is an effective surgical option to salvage brachiocephalic AVFs with excellent short-term and functional results (Fig).

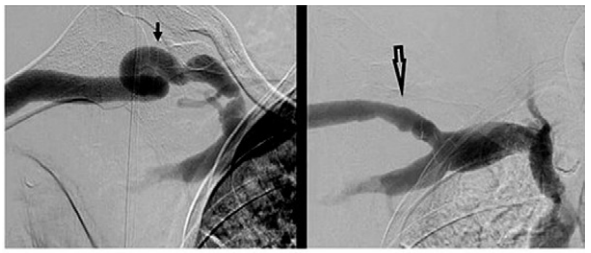

Fig.

Transarterial Treatment of Congenital Renal Arteriovenous Fistulas

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Objectives: Congenital renal arteriovenous fistulas (CRAVFs) represent a distinct and often misdiagnosed clinical entity with characteristic hemodynamic and angiographic features. Treatment is warranted given potential for growth with renal and hemodynamic compromise. We report our experience with a series of treated symptomatic CRAVFs.

Methods: During a 10-year period, patients treated for symptomatic CRAVFs (no history of predisposing renal pathology, instrumentation, neoplasm, or trauma) were retrospectively investigated for clinical presentation, radiographic features, treatment outcomes, and complications. A technically successful treatment included successful delivery of an embolic agent with complete obliteration of the fistula. Clinical success included resolution of symptoms and freedom from recurrence and reintervention. Renal parenchymal loss as demonstrated by postembolization angiography was categorized as 0%, <25%, 25% to 50%, or >50%.

Results: Twenty-five patients (8 women) were referred with a presumptive diagnosis of intraparenchymal renal artery aneurysm. Of these, 10 had true intrarenal aneurysms, three had angiomyolipomas, and 12 had CRAVFs (mean age, 54 years; range 29-71 years). Presenting symptoms included gross hematuria (n = 8), refractory hypertension (diastolic blood pressure ≥90 mm Hg despite ≥3 medications; n = 6), flank pain (n = 8), high-output state (featuring tachycardia and jugular venous distention; n = 3), and flank bruit (n = 1). Defining angiographic features included a high-flow arteriovenous fistula fed by a single, enlarged intrarenal branch shunting into a dilated vein, occasionally featuring a calcified rim (n = 4). All patients underwent transarterial embolization with coils (n = 5), coils and *n*-butylcyanoacrylate (n = 3), detachable balloons (n = 2), or Amplatzer plugs (n = 2). Technical success was 100%. Hematuria, tachycardia, jugular venous distention, pain, and bruit resolved in all. Hypertension improved in four of six patients (required one medication after embolization). Complications included a transient, self-limited postprocedural flank discomfort in nine patients. Parenchymal loss was limited to <25% and occurred in five patients. There were no recurrences or reinterventions at a mean follow-up of 55 months (range, 5-96 months). There was one death at 8 years' follow-up from intercurrent coronary disease in a patient without high-output state.

Conclusions: CRAVF is a rare and likely underdiagnosed clinical entity. With greater awareness and accurate diagnosis, effective and durable transarterial treatment can be safely performed (Fig).

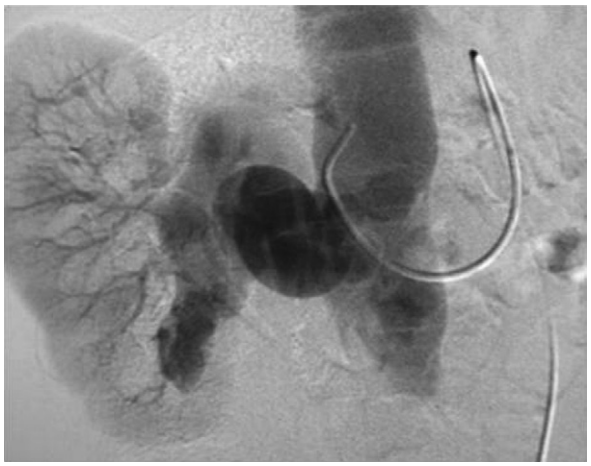

Fig.

Factors Associated With Primary Vein Graft Thrombosis in a Multicenter Trial With Mandated Ultrasound Surveillance

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Objectives: The benefits of preventing lower extremity vein bypass graft (LEVBG) occlusion through duplex ultrasound (DUS) surveillance and timely reintervention are established. However, even in the setting of surveillance, a significant number of LEVBG become occluded as a first event. We sought to identify factors that may contribute to these primary occlusions using a multicenter clinical trial database.

Methods: This was a retrospective analysis of the PREVENT III cohort of 1404 patients with critical limb ischemia who underwent LEVBG. Participants were followed up with DUS at regular intervals (1, 3, 6, 9, and 12 months), with reintervention based on prespecified DUS criteria. Patients who had graft occlusion as the initial graft-related event were identified, and technical failures (adjudicated) were excluded. Multivariate analysis was used to identify predictors of primary graft occlusion.

Results: Primary graft occlusion occurred in 200 participants (14%), accounting for 34% of all initial graft-related events. Primary occlusion events were distributed throughout the postoperative year. Rates of recur-